AMENDMENTS TO THE CLAIMS

Please amend the claims to read as follows. The following listing of claims will replace all prior versions, and listings, of claims in this application:

Listing of Claims:

1-12 (cancelled)

13. (New) A neural network, comprising:

a plurality of nodes forming at least two layers, a first such layer being an input layer and a last such layer being an output layer, said input layer nodes and said output layer nodes being communicably connected;

wherein data from a database is input to said input layer, and the results of processing said data are output from the output layer, the output layer nodes forming output channels;

wherein each node of the output layer outputs a transformation into output data of the input data received from the input layer said transformation comprising:

a first transformation step comprising at least a sub-step consisting in summing the input data received from the input nodes to the said output nodes by weighting the said input data, and

a second transformation step which transforms nonlinearly the results obtained by the first transformation step the output data obtained by the said transformation carried out in an output node being the output data,

wherein in each output node the first transformation step comprises two sub-steps:

a first sub-step being a nonlinear transformation function of the input data received by the output nodes from the input nodes,

and the second sub-step being the summing step of the said nonlinearly transformed input data in the said first sub-step.

14. (New) A neural network according to claim 13, wherein the input layer has a predetermined number of input nodes and the output layer has a predetermined number of output nodes;

wherein between the input and the output layer there is provided at least one further hidden layer of nodes, the nodes of said hidden layer being connected by weighted connection to the input nodes of the input layer and to the nodes of a further hidden layer when more than one hidden layer is provided or to the output nodes of the output layer, if only one hidden layer is provided;

wherein each node of the at least one hidden layer or of the more than one hidden layers and the nodes of the output layer carry out a transformation of the input data received from the input layer, or from a preceding hidden layer, into output data, said transformation comprising:

a first transformation step consisting in two subsequent sub-steps:

a first sub-step consisting in a nonlinear transformation function of the input data received by the output nodes, or by the nodes of a hidden layer, from the input nodes of the input layer or by the nodes of the preceding hidden layer,

and a second sub-step consisting in summing the said input data being nonlinearly transformed in the first sub-step by further weighting the said nonlinearly transformed input data, and

a further second transformation step being carried out which transforms nonlinearly the results obtained by the first transformation step,

wherein the output data obtained by the said transformation carried out in the said nodes being the output data if the nodes are the output nodes of the output layer or the input data furnished from the nodes of a hidden layer to the nodes of a following hidden layer or to the output nodes of the output layer.

15. (New) A neural network according to claim 14, wherein the input data of the nodes of the input layer consist in the input data of the database, while the output data of the nodes of the input layer are furnished to the nodes of the output layer or to the nodes of the first hidden layer or to the at least one hidden layer as input data of the nodes of these layers and the output data of the output layer consist in the processing result of the artificial neural network.

16. (New) A neural network according to any of claims 13-14, wherein the first nonlinear transformation sub-step of the input data carried out by a node comprises a transformation of the input data by means of a sinusoidal function and the second transformation sub-step consist in the sum of the input data after transformation by the sinusoidal function, i.e. after having carried out the said first transformation sub-step.

17. (New) A neural network according to claim 14, wherein each node of the at least one hidden layer and of the output layer comprises several input channels for different input data; to each channel being associated a receiver unit for carrying out the first nonlinear transformation sub-step of the first transformation step; a summation unit being further provided having an input connected to the outputs of the receiver unit of each channel and for carrying out the second transformation sub-step of the first transformation step by summing the nonlinearly transformed input data of each channel to a value and a nonlinear transformation unit having an input connected to an output of the summation unit for carrying out the second transformation step by nonlinear filtering of the value obtained by the first transformation step and furnishing the output value of the node which is the input value of the nodes of a following hidden or of the output layer.

18. (New) A neural network according to claim 16, wherein input data consists in a predetermined number of variables in a input data variable space, each variable being defined by coordinates in the input data space and each coordinate in the input data space being nonlinearly transformed in the first transformation step to a corresponding variable value which is made dependent upon the spatial position of the coordinate value with respect to a spatial wave of given wavelength, said dependence consisting in multiplying the input coordinate values by the wavelength of a sinusoidal wave which are then transformed into the same value, the wavelength of each input coordinate being tuned during the learning phase.

19. (New) A neural network according to claim 16, wherein the transformation of the input data carried out by each node is defined by the following equation

$$x_j^{[s]} = F\left(G\left(w_{ji}^{[s]}, x_i^{[s-1]}\right)\right) \quad (4)$$

wherein the *nonlinear transformation* $F(\bullet)$ is the nonlinear filtering function of the second transformation step and $G(\bullet)$ is the combination of the nonlinear transformation function of the first transformation sub-step and of the second linear transformation sub-step consisting in the sum of the non-monotonically, sinusoidal processed weighted inputs according to the following function:

$$G\left(w_{ji}^{[s]}, x_i^{[s-1]}\right) = \sum_{i=0}^{n} \sin\left(w_{ji}^{[s]} \cdot x_i^{[s-1]}\right) \quad (5)$$

wherein

$[S]$ is the generic layer of the network, with $s = 1$ for the input layer and increasing values for the hidden and output layers;

$\chi_j^{[s]}$ is the output variable of the $j-th$ node in layer $[S]$;

$\chi_i^{[s-1]}$ is the $i-th$ input to the generic node in layer $[S]$ from the $i-th$ node in layer $[s-1]$;

$\chi_0^{[s-1]}$ is a "false" input to the generic node in layer $[S]$, artificially introduced to represent, in a mathematically convenient way, a useful threshold value which is usually fixed to 1.

$w_{ji}^{[s]}$ is the weight on the connection joining the $i-th$ node in layer $[s-1]$ to the $j-th$ node in layer $[S]$; and

n is the number of inputs to the node.

20. (New) A neural network according to claim 16, wherein each node carries out a transformation of the input data according to the following function:

$$x_j^{[s]} = F\left(\sum_{i=0}^{n} \sin\left(w_{ji}^{[s]} \cdot x_i^{[s-1]}\right)\right), \quad (6)$$

the sine function introducing a qualitative process as each weight $w_{ji}^{[s]}$ plays as a 2π / *wavelength* parameter in the *i-th* coordinate of the input space of the *j-th* node of the *s-th* layer.

21. (New) A neural network according to claim 16, wherein the second nonlinear transformation step is carried out by means of a sigmoid function.

22. (New) A neural network according to claim 16, wherein said neural network is a multilayer back propagation neural network comprising a forward phase and a learning phase which uses a gradient descent principle,

the forward phase being defined by the following equations:

a first harmonic transformation step furnishing the transformed net input value I where

$$I_j^{[s]} = \frac{2\pi}{n}\left(\sum_{i=0}^{n} \sin\left(w_{ji}^{[s]} \cdot x_i^{[s-1]}\right)\right), \quad (7)$$

a second non linear transformation step by means of a so called activation function $f\left(I_j^{[s]}\right)$ determining the output of the node according to the equation:

$$I_j^{[s]} = f\left(I_j^{[s]}\right) = f\left(\frac{2\pi}{n}\sum_i \sin\left(w_{ji}^{[s]} \cdot x_i^{[s-1]}\right)\right), \quad (8)$$

and the learning phase being defined by the following equations:

the gradient descent principle

$$\Delta w_{ji}^{[s]} = -lcoef \cdot \frac{\partial E}{\partial w_{ji}^{[s]}}, \quad (10)$$

with usual Global Error functions, the error on each node is evaluated by defining the local error according to the equation:

$$e_j^{[s]} = -\frac{\partial E}{\partial I_j^{[s]}}, \quad (12)$$

thus obtaining:

$$\Delta w_{ji}^{[s]} = -lcoef \cdot \frac{\partial E}{\partial w_{ji}^{[s]}} =$$

$$= -lcoef \cdot \frac{\partial E}{\partial I_j^{[s]}} \cdot \frac{\partial I_j^{[s]}}{\partial w_{ji}^{[s]}} = \quad (13)$$

$$= lceof \cdot e_j^{[s]} \cdot \frac{\partial}{\partial w_{ji}^{[s]}} \left(\frac{2\pi}{n} \sum_k \sin\left(w_{jk}^{[s]} \cdot x_k^{[s-1]} \right) \right) =$$

$$= lcoef \cdot e_j^{[s]} \cdot \left(\frac{2\pi}{n} x_i^{[s-1]} \cdot \cos\left(w_{ji}^{[s]} \cdot x_i^{[s-1]} \right) \right),$$

and for determining the weights correction value, the local error $e_j^{[s]}$ being calculated as follows:

for the output layer:

$$e_j^{[out]} = -\frac{\partial E}{\partial I_j^{[out]}} = \quad (14) \quad ,$$

and for the other layers:

$$e_j^{[s]} = -\frac{\partial E}{\partial I_j^{[s]}} =$$

$$= -\frac{\partial E}{\partial I_j^{[s]}} \cdot \frac{\partial x_j^{[s]}}{\partial I_j^{[s]}} =$$

$$= -f'\left(I_j^{[s]}\right) \cdot \sum_k \left(\frac{\partial E}{\partial I_k^{[s+1]}} \cdot \frac{\partial I_k^{[s+1]}}{\partial x_j^{[s]}} \right) = \quad (15) \,.$$

23. (New) A neural network according to claim 22, wherein

the activation function of the forward phase $f\left(I_j^{[s]}\right)$ is the sigmoidal function

$$x_j^{[s]} = sigm\left(I_j^{[s]}\right) = \frac{1}{1+e^{-I_j^{[s]}}} \quad (9) \quad ,$$

the error function of the learning phase is the Medium Square Error function

$$E = \frac{1}{2} \cdot \sum_{k=1}^{m} \left(t_k - x_k^{[out]}\right)^2 \quad (11) \quad ,$$

the weight correction value for the output layer becoming

$$-\left(\frac{\partial}{\partial I_j^{[out]}} f\left(I_j^{[out]}\right) \right) \cdot \left(\frac{\partial}{\partial x_j^{[out]}} \left(\frac{1}{2} \sum_{k=1}^{m} \left(t_k - x_k^{[out]}\right)^2 \right) \right) =$$

$$= f'\left(I_j^{[out]}\right) \cdot \left(t_j - x_j^{[out]}\right) \ ,$$

and the weight correction value for the other layers becoming

$$- f'\left(I_j^{[s]}\right) \cdot \sum_k \left(- e_k^{[s+1]} \cdot \frac{\partial}{\partial x_j^{[s]}} \left(\frac{2\pi}{n} \sum_h \left(\sin\left(w_{kh}^{[s+1]} \cdot x_h^{[s]} \right) \right) \right) \right) =$$

$$- f'\left(I_j^{[s]}\right) \cdot \frac{2\pi}{n} \sum_k \left(e_k^{[s+1]} \cdot w_{kj}^{[s+1]} \cdot \cos\left(w_{kj}^{[s+1]} \cdot x_j^{[s]} \right) \right).$$

24. (New) A neural network according to claim 16, further comprising:

a receiving channel for input data;

a receiver unit associated to the said receiving channel for carrying out the first non linear transformation sub-step of the first transformation step;

a summation unit for carrying out the second transformation sub-step of the first transformation step by summing the non linearly transformed input data of each channel to a value; and

a non linear transformation unit for carrying out the second transformation step by non linear filtering of the value obtained by the first transformation step as defined by the previous step and furnishing the output value of the input nodes node which is the input value of the nodes of a following hidden or of the output layer.

25. (New) A neural network according to claim 22, further comprising:

a receiving channel for input data;

a receiver unit associated to the said receiving channel for carrying out the first non linear transformation sub-step of the first transformation step;

a summation unit for carrying out the second transformation sub-step of the first transformation step by summing the non linearly transformed input data of each channel to a value; and

a non linear transformation unit for carrying out the second transformation step by non linear filtering of the value obtained by the first transformation step as defined by the previous step and furnishing the output value of the input nodes node which is the input value of the nodes of a following hidden or of the output layer.

26. (New) A neural network according to claim 23, further comprising:

a receiving channel for input data;

a receiver unit associated to the said receiving channel for carrying out the first non linear transformation sub-step of the first transformation step;

a summation unit for carrying out the second transformation sub-step of the first transformation step by summing the non linearly transformed input data of each channel to a value; and

a non linear transformation unit for carrying out the second transformation step by non linear filtering of the value obtained by the first transformation step as defined by the previous step and furnishing the output value of the input nodes node which is the input value of the nodes of a following hidden or of the output layer.